CLAIMS

1. A method for selecting a maximum size for catalyst particles used in a multiphase reactor, wherein the multiphase reactor includes a liquid and a catalyst at conversion promoting conditions, said liquid having a density, ρ_L, and viscosity, μ_L, under said conversion promoting conditions and said catalyst comprising particles with a particle density, ρ_P, and particle sizes, d_P, the method comprising the steps of:

   (a) selecting a catalyst non-uniformity in the multiphase reactor;

   (b) determining an Archimedes number, Ar, corresponding to said catalyst non-uniformity; and

   (c) calculating a maximum catalyst diameter from said Archimedes number, Ar, according to the equation $d_P = \sqrt[3]{\dfrac{Ar\mu_L^2}{g\rho_L(\rho_P - \rho_L)}}$.

2. The method of claim 1 wherein the catalyst and conversion promoting conditions promote Fischer-Tropsch synthesis.

3. The method of claim 1 wherein the multiphase reactor comprises a slurry bubble column reactor.

4. The method of claim 1, wherein the catalyst non-uniformity is less than about 3, and the maximum catalyst diameter is equal to or less than about 250 microns.

5. The method of claim 1, further comprising the step of:

   (d) selecting a minimum catalyst diameter based on a minimum particle settling velocity, a filter permeability, or a combination thereof.

6. The method of claim 5, wherein the minimum catalyst diameter is equal to or greater than about 10 microns.

7. A method for determining an optimum catalyst particle distribution for use in a synthesis process comprising a separation system and a slurry bubble reactor, wherein the slurry bubble

reactor contains a liquid and a catalyst at conversion promoting conditions, wherein the liquid has a density, ρ_L, and viscosity, μ_L, under said conversion promoting conditions, and wherein the catalyst comprises particles having a particle density, ρ_P, and particle size, d_P, the method comprising the steps of:

(a) calculating a maximum catalyst particle size comprising the steps of:

(1) choosing a catalyst non-uniformity in the slurry bubble reactor;

(2) finding an Archimedes number, Ar, appropriate to the catalyst non-uniformity; and

(3) calculating the maximum catalyst particle size based on the Archimedes number according to the equation $d_P = \sqrt[3]{\frac{Ar\mu_L^2}{g\rho_L(\rho_P - \rho_L)}}$; and

(b) calculating a minimum particle size based on a separation property.

8. The method of claim 7, wherein the catalyst and the conversion promoting conditions are selected to promote Fischer-Tropsch synthesis.

9. The method of claim 7, wherein the separation system comprises at least one unit selected from the group consisting of sedimentation and filtration.

10. The method of claim 7, wherein the separation property is selected from the group consisting of catalyst particle terminal velocity, filter permeability, and combinations thereof.

11. A method for producing hydrocarbons from synthesis gas in a slurry bubble reactor, the slurry bubble reactor including a liquid and a catalyst at conversion promoting conditions, wherein the liquid has a density, ρ_L, and viscosity, μ_L, under said conversion promoting conditions and wherein the catalyst comprises a plurality of catalyst particles including fresh catalyst particles, the fresh catalyst particles having a particle density, ρ_P, and particle sizes, d_P, the method comprising the steps of:

(a) selecting the fresh catalyst particles such that the fresh catalyst particles have Archimedes numbers between about 0.02 and about 250, the Archimedes numbers being defined by $Ar = gd_P^3\rho_L(\rho_P-\rho_L)/\mu_L^2$; and

(b) passing a synthesis gas feed stream in said slurry bubble reactor over said catalyst under said conversion promoting conditions to convert at least a portion of said synthesis gas feed stream to hydrocarbons.

12. The method of claim 11, wherein a majority of said catalyst particles have particle sizes between about 10 and about 250 microns.

13. The method of claim 12, wherein the catalyst has an effectiveness factor in step (b) greater than about 0.7.

14. The method of claim 12, wherein the catalyst particles have an average Reynolds number of less than about 0.1, according to the equation $\mathrm{Re}_{avg} = \sum_{i=1}^{M} f_i \mathrm{Re}_i$, where f_i is the portion of particles in particle size fraction i, which is determined by dividing the number of particles in size fraction i by the total number of particles, which is N, and Re_i is the Reynolds number of particles of size fraction i.

15. The method of claim 11, wherein the fresh catalyst particles have Archimedes numbers between about 0.02 and about 100.

16. The method of claim 11, wherein the fresh catalyst particles have Archimedes numbers between about 0.2 and about 30.

17. The method of claim 11, wherein at least about 90 percent by weight of the catalyst particles have an Archimedes number between about 0.02 and about 100.

18. A process for producing hydrocarbons from synthesis gas in a slurry bubble reactor, the slurry bubble reactor including a liquid and a catalyst at conversion promoting conditions, wherein the liquid has a density, ρ_l, and viscosity, μ_l, under said conversion promoting conditions and wherein the catalyst comprises a plurality of particles with a particle velocity, v, the method comprising the steps of:

(a) selecting the catalyst particles such that the catalyst particles have an average Reynolds number of less than about 0.1, according to the equation

$\mathrm{Re}_{avg} = \sum_{i=1}^{M} f_i \mathrm{Re}_i$, wherein f_i is the particle size fraction, which is determined by dividing the number of particles of size fraction i by the total number of particles, and Re_i is the Reynolds number of particles of size fraction i; Re_i being defined according to the equation $\mathrm{Re}_i = \frac{\rho_l v D_i}{\mu_l}$, where D_i is the number average particle size of particles in size fraction i; and

(b) passing a synthesis gas feed stream in said slurry bubble reactor over said catalyst under said conversion promoting conditions to convert at least a portion of said synthesis gas feed stream to hydrocarbons.

19. The process according to claim 18 wherein the number average particle size is between about 20 and about 50 microns.

20. The process according to claim 19 wherein the number average particle size is between about 30 and about 40 microns.

21. The process according to claim 19, wherein the catalyst has an effectiveness factor in step (b) greater than about 0.7.

22. The process according to claim 18 wherein at least 90% of the plurality of particles have sizes between about 20 and about 150 microns.

23. The process according to claim 18 wherein the plurality of particles comprise a substantially log normal distribution of volume percent of catalyst particles versus particle sizes.

24. The process according to claim 18 wherein the plurality of particles have an average Reynolds number of between about 0.05 and about 0.06.